PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : H01L 21/00, 21/68 — A2

(11) International Publication Number: WO 00/42638

(43) International Publication Date: 20 July 2000 (20.07.00)

(21) International Application Number: PCT/NL00/00020

(22) International Filing Date: 13 January 2000 (13.01.00)

(30) Priority Data:
1011017 — 13 January 1999 (13.01.99) — NL

(71) Applicants (*for all designated States except US*): ASM INTERNATIONAL N.V. [NL/NL]; P.O. Box 100, NL-3720 AC Bilthoven (NL). KONINKLIJKE PHILIPS ELECTRONICS N.V. [NL/NL]; Groenewoudseweg 1, NL-5621 BA Eindhoven (NL).

(72) Inventors; and
(75) Inventors/Applicants (*for US only*): KUZNETSOV, Vladimir Ivanovich [RU/NL]; Buenos Airesstraat 8, NL-2622 AX Delft (NL). RADELAAR, Sijbrand [NL/NL]; Soestdijkseweg 378, NL-3723 HK Bilthoven (NL). VAN DER SANDEN, Jacobus, Cornelis, Gerardus [NL/NL]; Zomerland 42, NL-5663 HV Geldrop (NL). RUIJL, Theo, Anjes, Maria [NL/NL]; Vleugendaal 64, NL-6351 HE Bocholtz (NL).

(74) Agent: JORRITSMA, Ruurd; Nederlandsch Octrooibureau, Scheveningseweg 82, P.O. Box 29720, NL-2502 LS The Hague (NL).

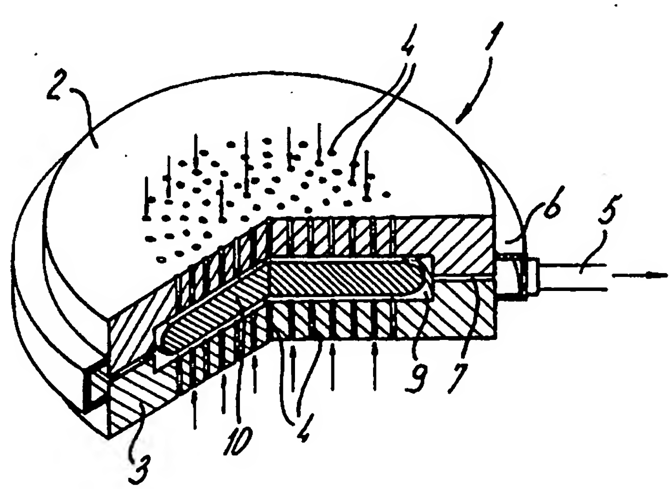
(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published
In English translation (filed in Dutch).
Without international search report and to be republished upon receipt of that report.

(54) Title: DEVICE FOR POSITIONING A WAFER

(57) Abstract

Device for the floating accommodation of a wafer. This device comprises two mutually opposite parts which delimit a chamber in which the wafer is placed. By gas being supplied from opposite sides, the wafer is held in a floating position. To prevent the wafer from touching the lateral boundaries, it is proposed to provide a discharge of gas at least partially near the circumference of the chamber wherein the wafer is accommodated. This discharge is realised such that if the wafer moves from the intended position to such a gas discharge, by closing of said gas discharge, the pressure is locally increased such that a force is generated acting in opposite direction to return the wafer in the intended position.



FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania
AM	Armenia
AT	Austria
AU	Australia
AZ	Azerbaijan
BA	Bosnia and Herzegovina
BB	Barbados
BE	Belgium
BF	Burkina Faso
BG	Bulgaria
BJ	Benin
BR	Brazil
BY	Belarus
CA	Canada
CF	Central African Republic
CG	Congo
CH	Switzerland
CI	Côte d'Ivoire
CM	Cameroon
CN	China
CU	Cuba
CZ	Czech Republic
DE	Germany
DK	Denmark
EE	Estonia
ES	Spain
FI	Finland
FR	France
GA	Gabon
GB	United Kingdom
GE	Georgia
GH	Ghana
GN	Guinea
GR	Greece
HU	Hungary
IE	Ireland
IL	Israel
IS	Iceland
IT	Italy
JP	Japan
KE	Kenya
KG	Kyrgyzstan
KP	Democratic People's Republic of Korea
KR	Republic of Korea
KZ	Kazakstan
LC	Saint Lucia
LI	Liechtenstein
LK	Sri Lanka
LR	Liberia
LS	Lesotho
LT	Lithuania
LU	Luxembourg
LV	Latvia
MC	Monaco
MD	Republic of Moldova
MG	Madagascar
MK	The former Yugoslav Republic of Macedonia
ML	Mali
MN	Mongolia
MR	Mauritania
MW	Malawi
MX	Mexico
NE	Niger
NL	Netherlands
NO	Norway
NZ	New Zealand
PL	Poland
PT	Portugal
RO	Romania
RU	Russian Federation
SD	Sudan
SE	Sweden
SG	Singapore
SI	Slovenia
SK	Slovakia
SN	Senegal
SZ	Swaziland
TD	Chad
TG	Togo
TJ	Tajikistan
TM	Turkmenistan
TR	Turkey
TT	Trinidad and Tobago
UA	Ukraine
UG	Uganda
US	United States of America
UZ	Uzbekistan
VN	Viet Nam
YU	Yugoslavia
ZW	Zimbabwe

Device for positioning a wafer

The present invention relates to a device according to the preamble of claim 1. Such a device is known from Dutch Patent 1003538, in the name of ASM International N.V. This document describes the individual treatment of wafers. A wafer is accommodated in a reactor, with the distance to the walls of the reactor being set to be comparatively small. It is thus possible for a particularly rapid heat transfer to take place. It is possible to heat the wafer to well above 1000°C within a few seconds. Since the wafer in principle does not have to be supported during this heating operation, but rather is held accurately in position by the gas streams, local temperature differences caused by mechanical contact are avoided. The very uniform heating of the wafer allows said short heating times to be achieved without the wafer becoming warped. Due to the high capacity of the reactor and the relatively low heat capacity of the wafer, in combination with the efficient heat transfer between the walls of the reactor and the wafer, so that the wafer quickly reaches the temperature of the reactor wall, this rapid heating of the wafer can be achieved with a relatively low peak capacity of the heating means in the reactor. The rapid heating of the wafer enables the total treatment time to be reduced, with the result that such a treatment is able to compete with the batchwise treatment of a series of wafers, while the consequences of problems remain limited to only one wafer.

In the prior art, it is proposed to provide the bottom part of the chamber with pins which can be displaced in the vertical direction in order to move the wafer into the loading and unloading position. During operation, such pins are inactive, since the wafer is then to be in the floating position. By suitably controlling the supply of gas for the various openings which lie on opposite sides of the wafer within the limits of the chamber in which the wafer is accommodated, the latter can be held floating in a very stable manner.

Although in the floating position the wafer is absolutely stable in the axial (vertical) direction, it has been found that the positioning in the radial (horizontal) direction provides problems: the wafer is able to move too easily in the radial direction. This is because of the position of the gas-supply and gas-discharge openings in the reactor, which openings can be regarded as an air bearing or gas bearing. In a radial air bearing which is known in the prior art, the air is supplied at the outside of the disc which is to be supported, and the air is discharged via an opening in the centre of the disc which is to be supported; this leads to stable radial positioning. In the present application, however, this form cannot be used, since it results in considerable pressure differences across the surface of the wafer, while a requirements for a uniform process result is that the range of pressure variation across the wafer is no greater than ± 2.5%. In the reactor described in Dutch Patent 1003538, of the applicant, stable positioning is achieved by positioning the gas-discharge openings along the circumferential side of the reactor wall. It has been found that, when the wafer moves in the direction of a discharge opening, closing the discharge opening brings about a local pressure increase in the vicinity of the discharge, and consequently the wafer is forced away from a discharge opening of this nature.

Therefore, the object of the present invention is to provide a device which allows extremely accurate radial positioning of the wafer during operation, i.e. during treatment.

This object is achieved, in a device as described above having the characterising features of claim 1.

According to an embodiment of the invention, the gas is discharged near the circumferential edge of the wafer from the device. If the wafer is moved from the optimum centred position, gas-discharge is locally hampered. Because of that, locally the gas pressure increases. At the opposite side the gas discharge can be improved such

that the pressure lowers. This gives a further biassing effect in correct direction. The discharge can comprise a circumferential ring or a number of openings being provided along the circumference of the chamber defined by the upper portion and lower portion of the device. The discharged gas can comprise the treatment gas but can also be a separate positioning-gas such that the feed of the treatment gas can be controlled independent of the feed of the positioning-gas.

According to a further possible embodiment, the gas is fed near the circumference edge of the wafer. At approaching the feed opening by the edge of the wafer locally the pressure increases and the wafer is moved back to the intended position. It will be understood that also combinations are possible of feed and discharge openings to obtain the centring effect described above.

According to a preferred embodiment of the invention, an additional opening is provided for introducing of a positioning-gas near the extremity of the wafer i.e. near the discharge for the gases. This gas moves over a part of the surface of the wafer which is not used to any beneficial effect and does not create any significant pressure differences. As a result, this gas can be supplied in relatively large quantities without producing unacceptable pressure differences, i.e. supplying gas for positioning purposes does not effect the treatment of the wafer, but does stabilise its radial position in the chamber in question. According to one proposal, such pressure differences are limited to ± 2.5%.

Basically, there are two possible solutions for the positioning of the gas-discharge opening and the positioning-gas supply opening respectively.

According to a first embodiment, the centre axis of the gas-discharge line is coaxial with the centre axis of the central plane of the treatment chamber. In this case, it is assumed that the wafer is situated in the centre of the treatment chamber in the position of use. Movement of the wafer towards the gas-discharge opening results in

this opening being closed off to a greater or lesser extent, thus producing a force which pushes it back. In this design, the positioning-gas supply openings are preferably arranged substantially perpendicular to the centre plane of the wafer to be treated.

According to an embodiment, these positions of gas-supply and gas-discharge openings are precisely reversed.

Both the gas-discharge opening and the positioning-gas supply opening may be designed in any way which is known in the prior art. The positioning-gas supply opening may comprise a number of openings which are arranged along (part of) a circle. If a complete circle is described, the position of the wafer is controlled in all radial directions. It is also possible for only part of a circle to be described, which is important if the wafer comes out of a supply channel which is connected to the treatment chamber. The positioning-gas supply opening may also be designed as a continuous slot or as a succession of elongate openings. The same applies to the discharge opening, which may be designed as a continuous ring or as a large number of openings or a number of slots. All this depends on the intended design and the desired operating conditions.

Since the positioning-gas is in principle not involved in the treatment of the wafer, it is possible to select a much less expensive gas, such as nitrogen, for this positioning-gas. It is, however, desirable for the gas to be supplied at the same temperature as the actual process gas, in order in this way to eliminate the effects caused by temperature differences as far as possible.

The invention is explained in more detail with reference to the drawings, in which:

Fig. 1 shows a perspective, partially cut-away, highly diagrammatic view of a structure according to the prior art;

Fig. 2 shows a first variant embodiment according to the invention;

Fig. 3 shows an altered version of Fig. 2;

Fig. 4 shows a further variant embodiment according to the invention,

Fig. 5 an embodiment with anti slip ring in cross-section and opened position;

Fig. 6 the structure according to fig. 5 in closed position of use; and

Fig. 7 the structure according to fig. 6 in a different cross-section.

Fig. 1 shows a highly diagrammatic view of a device for the floating accommodation of a wafer. This device is denoted overall by 1 and comprises a chamber 9 which is delimited by a top part 2 and bottom part 3. Treatment-gas supply openings 4 are present in both the bottom part 3 and the top part 2. Gas is discharged through opening 7, which is annular, and this opening 7 is connected to an annular channel 6 which is connected to a discharge line 5. The wafer to be treated is denoted by 10. Fig. 1 does not show the heating means and the structure for metering the gas through the openings 4. Accurate metering through each of the openings is of considerable importance in order to ensure that the wafer floats stably. The gas supplied on the one hand keeps the wafer in a floating position and on the other hand treats the wafer (chemically or physically). For a standard 200 mm wafer, the gas consumption is approximately 2-5 slm. With this design, it is readily possible to position the wafer in the axial direction, but radial stability is not achieved. No feed/discharge for the wafer is shown in the drawing. This feed/discharge may be either horizontal or vertical.

The invention provides stabilisation in the radial direction.

A first device which allows such stabilisation is shown in Fig. 2. In this case, the device is denoted overall by 11, the top part by 12 and the bottom part by 13. The supply openings for the process gas are denoted by 14. The discharge opening is denoted by 17 and is connected to a channel 16 which is connected to a

discharge line 15. Discharge opening 17 is designed as an annular gap. The space between top part 12 and bottom part 13 is denoted as chamber 19.

In addition to the above-described gas-supply openings 4 for treatment gas, there are also two positioning-gas supply openings 18 which lie opposite one another. In this design, these openings are designed as a circular groove which extends along the entire circumference of the top part 12 and bottom part 13. It is also possible for this groove to extend only over a limited part of the circumference. Gas from a different source from the gas which is introduced into the openings 14 (not shown) is introduced through this positioning-gas supply opening. The volume of gas is considerably greater than the volume of gas which is introduced via the openings 4. An example which may be mentioned is a ratio of approximately 1.5. This means that there is an increased flow of gas between openings 18 and discharge 17. This covers the end part of the wafer. Since this end part is not relevant for subsequent use, the fact that the process conditions are altered in that area compared to the remaining part of the wafer 10 is not a problem. With regard to the remaining part of the wafer 10, it remains the case that the process conditions must be as uniform as possible over the entire surface, and this is achieved by controlling the flow of gas at the various treatment-gas supply openings 14.

This means that a higher flow of gas through the openings 18 is readily permissible, and the result is a strong positioning action at the free end of the wafer.

Fig. 3 shows a variant of the design shown in Fig. 2. The device in accordance with Fig. 3 is denoted overall by 21. This device comprises a top part 22 and bottom part 23. The gas-supply openings for the treatment gas are denoted by 24. The space between top part 22 and bottom part 23 is denoted as chamber 29. The discharge opening is denoted by 27 and opens out into a channel 26 which is connected to a line 25. In the example shown in Fig. 3, the discharge opening 27 comprises a number of slots which

are distributed along the circumference. This enables further optimisation of the pressure profile between the positioning-gas supply opening 28 and these openings 27 to be provided. In an example for a 200 mm wafer, the distance between the wafer and the top part 22 and bottom part 23 was approximately 0.1-0.15 mm. The distance between the opening 28 and the slots 27 was approximately 4 mm, while the length of the slots 27 was approximately 5 mm, with a height of 0.25-0.50 mm, thirty such slots 27 being present.

It should be understood that the described shape of the positioning-gas supply opening and of the gas-discharge opening relates to the boundary face with the chamber.

Fig. 4 shows a further variant of the invention, which is denoted overall by 31. The top part is denoted by 32 and the bottom part by 33, while the supply openings for treatment gas are denoted by 34. As in the preceding Figures, the wafer is denoted by 10 and the chamber in which the wafer is situated is denoted by 39. 37 denotes the gas-discharge opening which is now no longer situated in line with the centre plane of the wafer, but rather perpendicular thereto. A channel 36 adjoins this discharge opening in a conventional manner. The positioning-gas is supplied through an opening 38. This opening may comprise a number of slots which extend in the tangential direction or a number of holes 38, as shown in Fig. 4. Variants which lie between these options are also possible.

Moreover, the end of chamber 39 is adapted to the shape of the end of the wafer (rounded off in an essentially identical way). Such adaptation may also be incorporated in the designs shown in Fig. 1-3.

In fig. 5, 6 and 7 a further alternative of the invention is shown. The wafer is transported therein with a so called anti-slip ring. This ring is referred to by 49 and is supported by a number of support fingers 47 of a support ring 46. The function of this ring is to realise heating and cooling of the wafer as uniformly as possible.

Through the heat capacity of ring 49 it is prevented that the wafer 48 is heated or cooled faster near its periphery than in its centre having adverse consequences. The device shown in fig. 5 and 6 is generally referred to by 40. As in the previous embodiments it comprises an upper portion 42 and a lower portion 43. In the closed position as shown in fig. 6 a compartment is delimited there between. The closed position of the upper portion 42 and lower portion 43 is determined by abutment cams 50. Ring 49 extends over the full circumference of wafer 48 and rests in closed position of the reactor on the cams or circumferential edge 51. 55 shows a duct for introducing of nitrogen. The gas emanating from this channel, functions as shield so that the treatment gas is confined in the reactor. 44 shows a discharge duct. It opens in a groove 53 wherein ring 49 is received. In fig. 7 the feed of wafer positioning-gas is shown by 45. Groove 53 is near cams 51 and support fingers 47 higher than on other locations along the circumference of the wafers, where to discharge the gas in outward directly only a narrow gap between the wafer and upper portion, lower portion respectively is provided as shown in the cross-section shown in fig. 7. The opening 54 is not shown on full scale and is somewhat enlarged relative to this gap. Because of that in this embodiment in the closed position as shown in fig. 6 and 7 this opening 54 will determine the feed of gas through the higher portions of the groove near the cams and support fingers to the enlarged outer portion of the groove 53 and the adjoining ducts 44. I.e. if for example wafer 48 moves to the left, the opening 54 shown in fig. 6 is closed and locally a pressure is built up so that the wafer is biassed to the right.

Except to provide a closure for the sealing gas by admitting nitrogen to channel 43, through the supply of additional nitrogen a further centring effect of the wafer is realised.

It will be understood from the above that there are numerous variants allowing a wafer to be positioned in a

chamber. It must be stressed that this positioning is not required along the entire circumference of the wafer. This will depend on the conditions. The variants referred to above lie within the scope of the appended claims.

Claims

1. Device (11, 21, 40) for the floating accommodation of a wafer (10, 48), for example for treating or for conveying thereof, comprising an accommodation chamber (19, 29) which is provided, on at least its underside, with treatment-gas supply openings (14, 24), in order to hold the wafer in a floating position, said device being provided with wafer-positioning means in the vicinity of at least one of its ends, characterised in that said positioning means comprise a gas-discharge (17, 27, 37, 44, 54) and a gas supply, opening in said accommodation chamber such that at displacement of said wafer from the intended position the flow resistance between the gas-discharge and gas supply increases at the side of said wafer in the direction whereof displacement has occurred, such that by pressure increase the wafer is urged back to the intended position.

2. Device according to claim 1, wherein said discharge comprises at least three openings being provided along the circumference of said accommodation chamber, each opening being at least closable by said wafer.

3. Device according to one of the preceding claims, wherein the centre axis of the gas-discharge and the supply (18, 28) for positioning-gas is placed such that the gas emerging therefrom has at least a component perpendicular to said centre plane.

4. Device according to claim 3, wherein said gas supply comprise supply openings for positioning-gas being provided near the outer limit of said chamber.

5. Device according to one of the preceding claims, comprising supply openings for treatment gas arranged to provide a treatment gas over the surface of said wafer.

6. Device according to claim 3 and 4, wherein the cross-sectional area of said supply opening for positioning-gas is at least 1,5 the cross-sectional area of the supply openings for treatment gas.

7. Device according to one of the claims 1-5, wherein the centre axis of said gas discharge opening (37) is

essentially perpendicular to the centre plane of the intended position of said wafer, and the positioning - gas supply opening (38) is arranged in such a manner that the stream of gas which emerges therefrom has at least one component which lies in the centre plane of the intended position of said wafer.

8. Device according to one of the preceding claims, wherein the said positioning-gas supply opening is elongate.

9. Device according to one of the preceding claims, wherein the treatment-gas supply opening and the said positioning-gas supply opening are connected to different gas sources.

10. Device according to one of the preceding claims, wherein the shape of the mouth of the gas-discharge opening substantially corresponds to the shape of the edge of the wafer.

11. Device according to one of the preceding claims, wherein said chamber (19, 29) is provided with positioning-gas supply openings on opposite sides.

12. Device according to one of the preceding claims, comprising a separate discharge opening for treatment gas.

13. Device according to claim 12, wherein said discharge opening is substantially provided in the centre of said chamber.

14. Device according to one of the proceeding claims, wherein in the opening of said gas-discharge opening a ring is provided.

fig-1

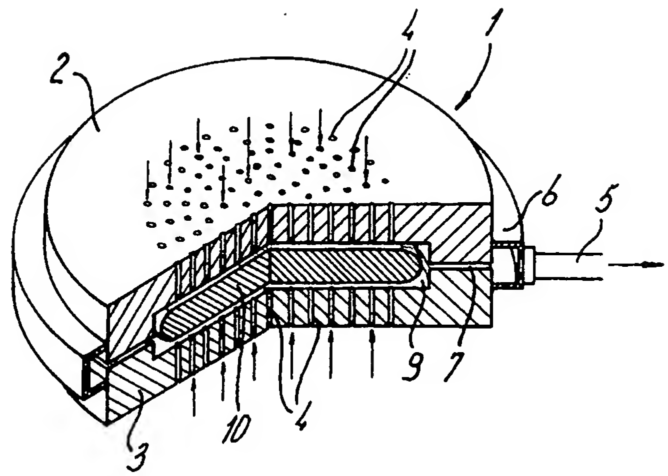


fig-2

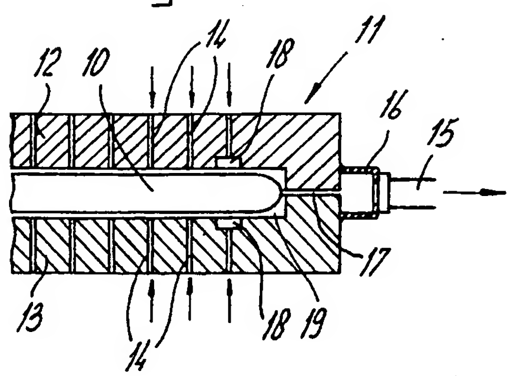


fig-3

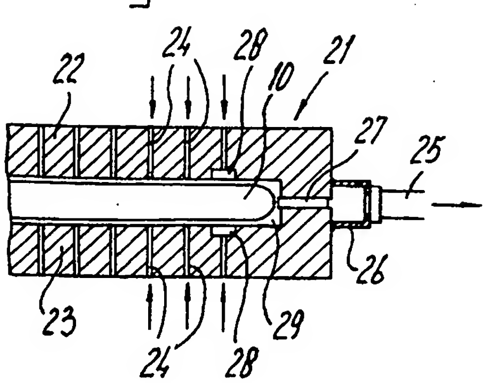


fig-4

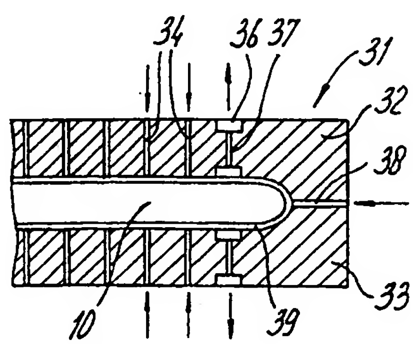


Fig-5

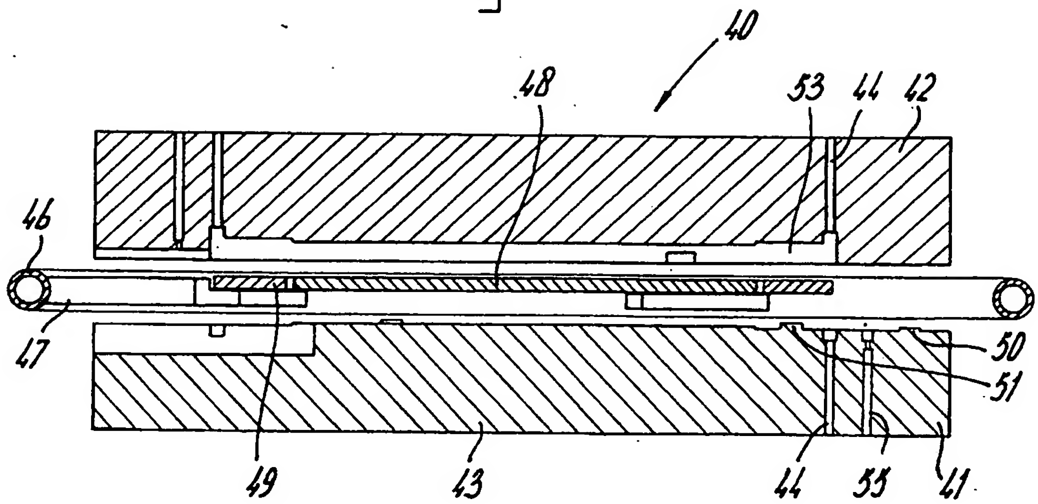
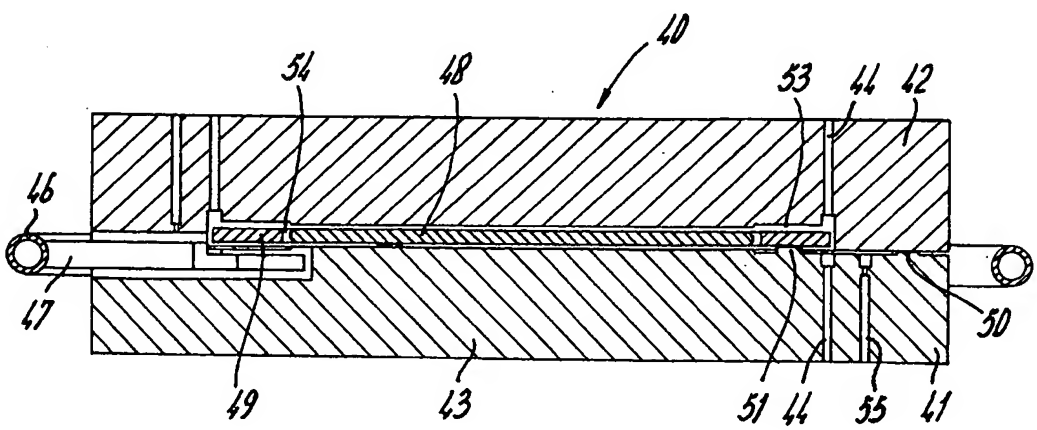

40
48
53
44
42
46
47
50
51
49
43
44
55
41

Fig-6


40
54
48
53
44
42
46
47
50
49
43
51
44
55
41

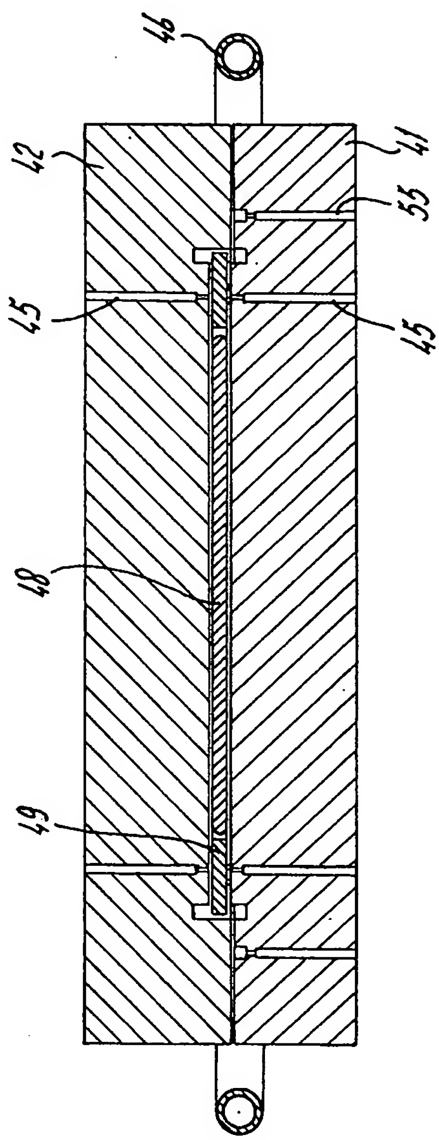


Fig - 7